

"A CLINICAL STUDY OF CHLOROFORM"

by

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In taking the subject of Chloroform Anaesthesia for my thesis I have been influenced by three main considerations.

Firstly, the importance of the subject, an importance which since my student days has ever been increasingly impressed upon my mind; the more experience I have had of chloroform narcosis, the more has been forced on my attention the necessity of the most careful teaching to medical students of the nature of the drug and its direct and remote effects, and of the absolute caution and attention demanded of all practitioners in administering this form of anaesthetic, that each one by experience may become expert in its management.

Secondly, I wish to discuss at some length the relative safety of chloroform as compared with ether as a general anaesthetic in so far as one can do so by experience and by the study of the published records of fatalities which have occurred from the administration of either of them.

And thirdly I desire to embody here my experiences with chloroform in such a climate as South Africa, where/

where while acting as Civil Surgeon with H.M. forces, I held the post of Anaesthetist to No. 8 General Hospital, Bloemfontein, for five months; and to compare its action under the conditions there obtaining, of fresh air, high altitudes and active service with that observed in our own climate, temperate indeed but often unfortunately without the advantages of fresh air, so difficult to obtain in our crowded cities.

Into the subject of anaesthesia produced by the use of Ether alone or combined with nitrous oxide, of nitrous oxide alone, I do not propose to enter here. I have had no experience of anaesthesia produced by Lumbar puncture into the subdural space of the spinal cord with cocaine, a practice which has been successfully tried on the Continent and at home - nor does a consideration of other general anaesthetics such as amylene pental, dichloride and bromide of ethyl fall within the scope of this essay.

History of Anaesthesia:

Attempts at the production of Local and General Anaesthesia have long been practised and form one of the most interesting chapters of Medical History. By the Egyptians, Chinese and Jews sedative draughts principally/

principally composed of Cannabis Indica, were early used to relieve the pain of death and the use of various drugs is mentioned by Homer in the "Odyssey". The Romans in order to alleviate the pain of incisions were in the habit of benumbing the part by applying to it a mixture of Vinegar and finely powdered marble, when the fumes of Carbonic Acid gas are given off and produce some degree of local anaesthesia. The Scythians were accustomed to produce some general anaesthesia by the inhalation of the fumes of burning Cannabis Indica. And so until the beginning and even well into the last century, before the introduction of chloroform, ether and nitrous oxide, the custom was by large doses of opium, cannabis indica, and other sedatives, combined with the free use of stimulants, to dull the senses, in order that by reducing as far as possible the attendant pain and shock operations such as amputations, could be efficiently performed. We have all of us met practitioners who have seen such operations performed, or read of them, and to compare such suffering with its absence under a general anaesthetic proves to us the immense strides that have been made in the last 50 years in this branch of Medical Science alone.

Before the introduction of the general anaesthetics in use now various steps were taken and numerous expedients/

expedients made use of with the hope of producing some form of anaesthesia. In the sixteenth and seventeenth centuries the Italians introduced a method of operating while the patient was stupified by compression of the carotid arteries and thus depriving the sensory areas of the brain of blood. On the same lines, Ambrose Pare early suggested that by compressing the main nerve trunks of a limb a condition of anaesthesia might be produced in that part. This practice was revived in 1874, when John Hunter is recorded to have amputated a leg, local anaesthesia being produced by compression of the sciatic and crural nerve trunks. The methods of bleeding to syncope, surely a dangerous preliminary to the shock of an operation, and of giving alcoholic stimulants to the point of intoxication, were also used. Dr Mesmer, by the introduction of so-called Animal Magnetism raised a subject which, in its intricacies of Hypnotism and allied states, has not to this day been satisfactorily explained. Undoubtedly a state of unconsciousness, during which many operations are possible, has been and can be produced by the effects of the physical force of one brain on another, yet there are many insusceptible to such a force, and the danger of such Mesmerism on the mental state cannot be overestimated. The late Professor Sir Thomas Grainger/

Grainger Stewart, writing on the subject in the Lancet of October 21st, 1893, says: "In every case hypnotic treatment involved hazard to the nervous system and those who were most susceptible to its treatment were the most apt to suffer, and that though it might free the patient from one set of symptoms, it was liable to make him the victim of many others." So the disuse of such treatment for the production of general anaesthesia has been well deserved.

The use of Nitrous Oxide Gas was first suggested by Humphrey Davy in 1799 in his volume of Researches, where he says: "As nitrous oxide gas by its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." But the credit for the first practical use of this vapour must be given to Horace Wells, an American dentist, who in 1844 had a molar tooth removed while under its influence.

An Arabian Chemist is said to have discovered Ether and its physical properties were long known before its practical application. In 1818 this sentence appeared in the Journal of Science, "When vapour of ether is mixed with air and inhaled, it produces effects very similar to those occasioned by/
by/

by nitrous oxide."

A Dr Long of America in 1842 stated he had succeeded in painlessly removing a small tumour under the influence of ether. Ether then began to be extensively used in dental practice, and was introduced to London in 1846, when Liston amputated a leg through the thigh, while the patient was under its influence.

The introduction of chloroform in 1847 by Sir James Y. Simpson will always remain to the glory of our Medical School, and the publication of his paper, "Notice of a New Anaesthetic agent as a Substitute for Ether." soon brought this drug to the notice of the medical profession and placed it in the fore front of general anaesthetics, a place it has deservedly well maintained. The interesting experiments performed on Drs Keith, Matthews, Duncan and himself, will long remain landmarks in the history of medical progress. /f

Nature:

The composition of the drug used as an anaesthetic is Chloroform or Trichloro-methane, to which has been added sufficient absolute alcohol to produce a liquid having a specific gravity of not less than 1.490, and not more than 1.495, Alcohol being added in small quantities to prevent decomposition. It is a colourless, heavy liquid, with a characteristic/

istic odour and sweet taste, insoluble in water and not combustible, but when mixed with alcohol burns with a smoky flame, having a greenish edge.

The preparation is made in several ways, but the more usual one is by distilling dilute alcohol with calcium hypochlorite in the presence of calcium hydrate. After distillation the product is carefully purified and on the thoroughness of this process depends the safety of the chloroform narcosis. It can also be manufactured from methylated spirits or from acetone. It is said that chloroform possesses a physiological action, varying in a slight degree with the source from which it is derived.

If exposed for some time to light it splits up into chlorine and hydrochloric acid. The absence of any of the following tests denotes the presence of impurities in the preparation.

- (a) Characteristic sweet odour, and upon evaporation leaving no odour.
- (b) Neutrality to test paper.
- (c) Specific gravity, 1.490 to 1.495 and boiling point 60° C.

There are several other and more complicated tests, but these are usually sufficient and easily demonstrated.

Introductory Remarks:

To attain to a marked degree of proficiency in the/

the production of chloroform narcosis should be the aim of every student and practitioner, for the responsibility of using a drug which may, by overdosage, cause the patient to pass beyond the confines of sleep to those of death. ^{is great} Hence the watchword of the administrator must be "Carefulness", and his duty to reach the happy medium of full and efficient anaesthesia, combined with safety. To reach this high standard he must be fully conversant with the effects of the drug in all its stages, and therefore the need of its careful teaching to students is evident. It is most important that every student should himself administer the drug as frequently as possible under the supervision of a well qualified anaesthetist appointed for the purpose of such teaching, and supervision, and not to give the drug himself except in a precarious case. Nobody can possibly learn properly the administration by watching, but must himself be the anaesthetist. For the fault of timidity, due to want of faith and experience, is equally culpable with that of recklessness, due to want of knowledge both of chloroform narcosis and the responsible position of the anaesthetist in handling the drug, which in careful hands is one of the benefactors of our age, yet may, should any fatality occur, bring discredit on our profession. Yet in even the most/

most experienced and careful hands accidents have, and always will happen. This cannot be otherwise when the drug is used so frequently and in many cases to an organism already enfeebled by disease. The cause of such deaths is often very obscure and has been variously ascribed to idiosyncrasy, fear, or to heart failure. So much the more then must the administrator remember his watchword of "Carefulness" and look on every new case as an entirely different organism, both as regards health and temperament.

By a kindly and reassuring manner much can be done and how necessary it is to remember that we are dealing with patients unused to anaesthesia, and in many cases already enfeebled by disease and rendered more highly strung and nervous on this account.

The anaesthetist should always be fully prepared for any serious symptoms which may arise and should have ready at hand every preparation and appliances which may be required. His kit should include the following:--

(a) The drugs, a choice having been made beforehand, if possible, to suit the requirements of the operation and patient.

(b) A suitable form of apparatus for giving the drug, i.e. an inhaler, such as Junker's, with the/

the attached mouth and nasal tube for operations on these parts - or as very many people, including myself, prefer a drop bottle for the Open Method, Against the open method it is ~~so~~ often said that one cannot gauge the dose of the drug given as one can with an inhaler. But I hold that one can by a careful study of the patient and of the symptoms of the various degrees of anaesthesia produced gain as sure a record of the dosage which is produced as one can by any mechanical means. For it must be remembered that a dose which is safe for one person may not be for another, and to automatically give a certain fixed dose by mechanical apparatus is not, I hold, the best or most justifiable method, nor can it be said to be scientific. The point most necessary to remember is that proper dilution of the vapour must always be insisted upon whatever method be adopted. In the words of the Report of the Lancet Commission, "The main point forced on us is, that more depends on the person giving the anaesthetic than upon the method he adopts."

(c) The kit should also comprise - mouth gag and tongue forceps, sponges and holders; tracheotomy instruments should also be at hand, and always a hypodermic syringe, with some preparation of strychnine. Should oxygen and bellows be available they/

they are most useful but few practitioners can carry such things about or for the matter of that have them at hand; Nitrate of Amyl and stimulants are also useful.

Every article to be used should be carefully overhauled before each operation and those which come in contact with the face and mouth carefully cleansed in a 5% Carbolic Lotion in order to prevent the dissemination of disease. One cannot lay too much stress on the last point for how unfortunate it would be should the anaesthetist in his endeavours to assist in combatting one disease be the means of communicating another perhaps far more loathsome.

Preparation of the Patient.

In giving chloroform it is wise to remember that it should be administered when the patient is as far as possible under the most suitable bodily circumstances. When strong and healthy this is not so much of importance as when weakly and enfeebled by disease. Thus, if it can be avoided, the administration should not be after^a fast or late in the day when the body is tired. As to feeding it is a good rule to observe that with the exception of a little beef tea or other easily digestible nourishment about four hours before, the patient should have nothing for at least six hours before the time fixed for the operation./

operation. As to time of operation the most suitable hours are 8 a.m. and 2 p.m., when the activity of the body is greatest. The state of the bowels must be regulated, preferably by *Oleum Ricini* half to one ounce, or a saline purge over night and followed by a simple enema in the morning. In debilitated patients just before the anaesthetic is given an enema of brandy and beef tea is to be recommended.

When the patient's heart is dilated or acting feebly, expectant treatment should be the administration of 1 dram of *Sal Volatile* or an hypodermic injection of five minims of *liquor strychninae*. The necessity of knowing, previous to narcosis, the exact cardiac condition of the patient cannot be over estimated, thus putting the administrator on his guard against any complication of heart failure which may arise. In estimating the cardiac condition it is not merely sufficient to apply the stethoscope to the mitral and aortic areas, and to be satisfied if no murmur exists. That is often unimportant, for a murmur - and the louder the safer - is no contraindication to the use of chloroform. The heart must also be examined by percussion, and a note made of the presence of dilatation and by auscultation the rhythm, force and strength of the heart's action can/

can be estimated and must be noted.

When all is ready, the administrator should by manner and kindly words reassure the patient as far as possible. These details are of importance when the danger of fear causing cardiac inhibition is remembered, for it is recorded that fright has caused death, even when an innocuous substance was inhaled.

The patient should be placed on his back comfortably, with a single pillow under his head, which pillow can be later removed. It is unjustifiable and dangerous to give chloroform in any other position, such as sitting or reclining, for deaths have been recorded which were undoubtedly due to improper posture. The clothing, which should be as light as possible, must be loosened, especially around the neck and abdomen.

The mouth is to be examined for false teeth or any other foreign body, and these should be removed. The inhaler or mask is then to be shewn to the patient without any chloroform vapour being present, and gently placed over the face, covering the mouth and nose. The patient should be instructed to breathe quietly and naturally, and I find an excellent method of distracting the patient's thoughts is to make him count numbers. Then vapour of chloroform should be allowed to be inhaled by dropping the drug/

drug carefully and gradually on to the mask.

In private practice the room in which the anaesthetic is to be given should be as light and airy as possible, one in which that great essential, free admixture of air, can be maintained. I think it a good plan to always keep a window to some extent, dependent on the temperature, out of doors, open at the top and bottom, thus ensuring a free circulation of fresh air. There can be no doubt that the reason why there are so few fatalities from chloroform in such tropical and semi-tropical climates as India and South Africa is that the drug is given often on the verandah in the open air, or at any rate, in rooms built with a large cubic air space and free ventilation, thus ensuring plenty of fresh air.

It is also advisable that when possible the patient should be anaesthetised before being taken into the operating room, and so reducing all fear. In private practice this is often impossible, but here, preparations for the operation should not be made manifest before consciousness is lost. The danger of administering chloroform in a room where free gas lights or lamps must be borne in mind, for then a pungent irritating smell arises, due to the liberation of carbon oxychloride and Phosgene gas.

My/

My Experiences in South Africa:

While serving as a Civil Surgeon with the troops in South Africa during 1901 I was for several months stationed at No.8 General Hospital, Bloemfontein, and for five months held the appointment of anaesthetist. During this time I gave all the anaesthetics for the various operations performed, the total reaching 75 and including mostly major operations, such as high amputation for gunshot wounds, colotomies and herniae, nephrectomy, for abscess of liver and many others.

Chloroform, on account of its portability, ease of manipulation, and simplicity of administration I found the most useful and satisfactory anaesthetic and gave it in all but two or three cases, without, I am happy to say, a single fatality due to the drug itself. Ether I did not often use, on account of the cumbersome apparatus, and the rapid evaporation, which rendered the period before unconsciousness was reached so much greater. But where the patient was weakly or collapsed, I was in the habit of using it in the succession to chloroform.

Nitrous oxide gas I never used, as it is unsuitable for use in those latitudes, owing to its liability to decompose and the difficulty of keeping it in/
in/

in the hot weather experienced up country, though I believe it was in use at the sea coast towns. This series of 75 cases was particularly of interest to me for the following reasons, (1) The anaesthetic was given at a high altitude in a more or less rarified atmosphere, Bloemfontein being 4,000 feet above sea level, and (2) It was given under conditions of Active Service to soldiers, who though they were hardened by campaign, yet on account of the previous alcoholic habits of the majority, were subjects who were likely to struggle a great deal under the administration and not likely to take the drug well. But the element of nervousness or fear on their part had never to be taken into consideration, and I may perhaps in passing testify to the pluck and endurance of Thomas Atkins, which qualities render him the best and most obedient patient any medical man can wish to have.

Apparatus used:

Ether, when given, was administered with an ordinary Clover's Inhaler, and the product used was the Ether Purificatus of the British Pharmacopoeia. The chloroform, which I have before stated was the drug almost invariably used, was Duncan & Flockhart's Ethylic Chloroform in 4 oz. bottles. I administered it/

it on a Skinner's mask covered with a double fold of plain lint and gave it from a 2 oz. drop bottle.

To prevent decomposition in such a climate the necessity of keeping it in the coolest and darkest place was to be remembered, but even then possibly owing to the heat it was very difficult to be sure of good standardisation. Many times all present in the operating theatre have complained of the pungency of the vapour and certain cases in which symptoms of cyanosis and respiratory embarrassment have arisen, were I am sure due to the decomposition of the drug. It was impossible to test fully the purity of the drug; the colour was never other than it should have been, but the odour was acrid and pungent. So it will be seen how difficult it was to be certain of the chloroform in use and this fact made the necessity of care the more marked.

Surroundings:

The anaesthetic was always administered on the table in the operating room. This room consisted of the ordinary type of Hospital Hut in use and was made of an external surface of galvanized iron which, with the sun beating down, made the interior very hot. There was a space of about four inches between this and a lining of wood. The size was about 20 feet square/

square, with a room 4 ft x 5 ft. used for photographic purposes partitioned off, the total cubic air space then being about 3000 cubic feet.

There were two windows, one on each side, facing each other and a door at one end. Thus when these were open there was always a free current of air, but often it was not possible to open these on account of the prevalence of dust storms, as dust would have permeated everything and infected the operation wound. In this limited space there were usually several spectators, without counting the operator and his assistant and nurse, so combined with the heat of the sun, the atmosphere often became very hot and contaminated - a condition most prejudicial to the proper action of the anaesthetic.

The amount of chloroform I used in any given case varied widely, depending on the length and degree of anaesthesia necessary. But on account of the rapid evaporation it was always greater than one would use for a like operation in our own temperate climate. For an operation lasting about 15 minutes I found about half an ounce necessary to produce total abolition of the reflexes. For an operation of 30 minutes three quarters to one ounce, and when lasting an hour or longer, an ounce and a half to two ounces, or even more. So it will be seen/

seen that large amounts were necessary to produce complete and efficient anaesthesia, and the reasons were the rapid evaporation, and the class of patients - healthy, yet the majority previously alcoholic.

I propose now to pass to the question of chloroform anaesthesia in general and shall make special detailed reference later to cases in South Africa.

Chloroform Anaesthesia:

The physiological action of chloroform in producing narcosis depends on its selective effect on the nervous system. The vapour having been taken into the air vessicles of the lungs is absorbed into the general circulation. Here it is probable that it is absorbed into the red corpuscles in some loose chemical combination, with haemoglobin taking the place of the oxygen normally present. It is thus carried to the brain and there ^{is} able to exert its selective action and produce anaesthesia. Probably here also some loose chemical combination is produced with the nerve cells of the cerebral and medullary centres. Its first action as shown by talking and struggling, is to stimulate and then to paralyse such centres. The order in which it acts on the several centres is first the more highly/

ly specialised ones of thought and co-ordination of movements; then the motor and sensory; and lastly the vital ones of the medulla, death eventually occurring from failure of the respiration due to paralysis of that centre. That chloroform has a special affinity for action in the nervous system is shown by the large amount of the drug found in it post mortem, as compared with other tissues. It cannot be that chloroform produces its unconsciousness merely by mechanically replacing the oxygen of the blood, for then partial asphyxia alone would be sufficient narcosis for operative procedures. When its vapour is sufficiently concentrated to produce saturation of the blood no doubt it can replace all the oxygen present, but death in such a case would not be primarily due to asphyxia, but to the toxic effect of chloroform.

The formation of some loose chemical combination, both with haemoglobin and the protoplasm of nerve cells, which can be replaced again by oxygen necessary for their life, is shown by the rapid recovery which may take place, under artificial respiration; on the other hand, the failure of artificial respiration to bring about recovery in such/

some cases shows that it is not the mere replacing of oxygen which causes death, but the toxic effect of the drug itself on the vital nerve centres.

The antidote then for chloroform poisoning is oxygen, which causes it to be thrown again into the general circulation and excreted by the lungs, liver and kidneys. It has been shown that when chloroform is injected directly into the circulation it does not paralyse the heart, but acts just as if it had been inhaled and produces anaesthesia with a fall of blood pressure. Ether, on the other hand, causes coagulation of the blood. In the production of anaesthesia the vapour of chloroform continues to enter the lungs till a balance is maintained between the tension of the drug in the residual air of the lungs and that in the blood itself.

This fact is formulated into Snow's Law, "As the proportion of vapour in the air breathed is to the proportion that the air or spaces occupied by it would contain if saturated at the temperature of the blood, so the proportion of vapour absorbed into the blood to the proportion the blood would dissolve."

The amount of vapour which can be taken up by the/

the air of the atmosphere varies with the tension of chloroform at different temperatures. Thus Dr Snow gives the following figures in his work:-

At 40°F., air percentage = 94, Chloroform vapour percentage = 6.

At 90°F., " " = 65, " " = 35

At 130°F., so much chloroform would volatilize as to give rise to almost pure vapour.

These facts had always to be kept in mind in South Africa where the temperature rose in the hot weather to 90°F. and even more in the operating theatre. On administering by the open^{method,} it was not possible to regulate exactly the amount of chloroform vapour given to the patient except by extreme care and watchfulness of the signs of narcosis. Yet as I have before mentioned, I consider such care with the open method is the best safeguard in judging of the degree of anaesthesia.

It is usual to divide Chloroform Anaesthesia into five degrees.

The first degree extends from the beginning of the administration to the beginning of the loss of consciousness, which loss is shown by sensations of fullness in the head, ringing in the ears and some diminution of ordinary sensation. Pulse and respiration are a little quicker and there is a transient rise of blood pressure followed almost at once by a fall.

During the second degree there is violent struggling and mental confusion, sensation to pain being blunted. The patient may talk or laugh and may attempt to remove the facepiece. Respiration and/

and Pulse are quickened and blood pressure is more weakened. This degree is often enough for slight operations in children, in midwifery and the later stages of more prolonged operations, for patients as a rule do not remember pain or anything which may have occurred.

In the third stage there is loss of voluntary movements associated with rigidity and spasm of muscles and loss of all reflexes except the Rectal influence on Respiration. This is the stage in which nearly all operations can be commenced and carried through, and it is the duty of the anaesthetist to see that this stage is safely reached before allowing the operation to begin. This point is of importance, for several deaths have been recorded from Cardiac Inhibition due to the stimulus of the skin incision in a patient in whom this degree has not been fully reached. The Conjunctival Reflex is lost and is commonly taken as the guide to the production of this stage. The pupil, I think, is far more important and should be always carefully watched. When full anaesthesia is reached, it contracts almost to a pin point and an overdose of chloroform is marked by wide dilatation.

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On the other hand, should the narcosis not be deep enough or the patient, if I may use the expression, be asleep under the anaesthetic, the stimulus of the skin incision will cause it also to dilate widely and the patient will pass back into the second degree and the danger of Cardiac Inhibition is present.

So I am in the habit after contraction of the pupil has been produced, showing that the third degree has been reached, to give a little more chloroform sufficient to cause dilatation to begin. Then the patient is ready and fully under, the stimulus of the skin incision only causing the narcosis to pass back into the third degree. During the Third stage, the tongue and buccal muscles are relaxed and to prevent the tongue falling back, it is necessary to place the fingers under the angle of the jaw and so to pull it forwards.

In the Fourth degree, stertorous breathing, dilatation of the pupil and complete muscular relaxation are met with. This is a dangerous state and the early stage of it is only necessary in cases of old standing dislocations, where heart failure may occur from shock, in rectal operations to prevent/

vent the Respiratory reflex, in deep dissections where pressure may arise on deep ganglia, and in alcoholic patients. In the later stage of this degree, the breathing becomes shallow, difficult and irregular, the pulse feeble, quick and easily compressible and then should the vapour be not removed, the patient passes into the Fifth degree of extreme danger. This stage extends from the embarrassment to total cessation of respiration and death supervenes from paralysis of the Medullary Centre for that function. The Heart ceases after in a state of Paralytic Dilatation and the pupils are widely dilated.

Therefore, the aim and object of the anaesthetist in all the ordinary operations of surgery is to produce and maintain as long as necessary, the third degree of anaesthesia, to judge by loss of reflexes and sensation, by flaccidity of muscles and size of pupil when such a degree has been reached. And it is his duty not to allow the operation to begin till such has been produced. As I have already mentioned, a deeper degree may be necessary in some cases, but is to be looked upon as dangerous and needing the greatest possible care.

The question of the necessary amount of chloroform/

form to produce the several degrees of Anaesthesia was carefully worked out by Dr Snow and his deductions were, calculating the weight of blood in the body as 30 pounds and at a temperature of 60° F., that twelve minims of Chloroform in the circulation produces narcosis of the second degree, eighteen minims the third degree, twenty-four minims the fourth degree of deep narcosis and that thirty-six paralyses the medullary centres.

To return now to my experience in South Africa, it must be remembered that there I was dealing with a probably alcoholic class of men and that the operations were carried out at a high altitude, calculating at a rough estimate that the theatre where I gave the anaesthetic was 3000 cubic feet, and the temperature often higher than 60° F. it will be seen that owing to the rapid evaporation, a greater amount of chloroform was necessary to produce the several degrees than would be the case in our own more temperate climate.

My experience was that for the first degree of anaesthesia about two drams was necessary. The second degree, I always found the most troublesome owing to the before mentioned reasons and the necessity for concentrating the vapour. There was always/

ways a large amount of struggling before quietness and loss of reflexes were produced, and a quarter to half an ounce, I found necessary to produce this state. I found it often useful, when struggling was violent, though I own it a dangerous practice, to place a towel over the mask and thus prevent rapid evaporation, but immediately removing when quietness was established. When doing this it is most necessary to watch carefully to prevent over dosage, but I never had any bad result from use of this method and I found that the patient quickly went under.

For the third degree, I found half to one ounce necessary and when reached, except in certain cases, the operation I allowed to begin, taking as my guide to the establishment of full narcosis, reflexes, size of pupil, respiration and loss of all painful sensation.

When it was necessary to reach the fourth degree, I found about an ounce and a half was used. In my series of 75 cases, I had no untoward case in which dangerous symptoms arose from the effects of chloroform. One death occurred on the operating table, but this was due to the shock of a thigh amputation/

putation in a Boer already enfeebled by suppuration of the knee joint of two months' standing, but I shall refer later to this in my summary of cases.

Recovery from Chloroform Anaesthesia.

When the operation is over, the patient should not be removed from the table for half an hour, but kept with the head low and carefully watched till consciousness is regained. Most people awake as from sleep in about fifteen minutes with little unpleasant after effects. Old people are said to take longer in waking. Should the patient be inclined to sleep on, let him do so by all means, as he will awake much refreshed and without the after sickness. It is a most unjustifiable practice to slap the face or use other methods to make the patient speak "just to see if he is all right". Such a practice is liable to give rise to after sickness and other complications, to say nothing of the production of a black eye!! which I have seen happen.

On no account must the patient when consciousness is regained be allowed to sit up, for fatal heart failure has followed such a practice.

Complications - Vomiting.

This most frequent and distressing complication may occur at either of two stages. First, during the operation, and it is then due to return of consciousness and reflexes. As it is due to insufficient chloroform, the treatment is increase the amount given. The vomited matter, unless food is present in the stomach, only consists of mucus. Second, after the operation - is due to the effect of the drug itself and is combatted by strict attention to the preliminary rules regarding the abstinence from food. The presence of food in the stomach may also cause vomiting during the administration of chloroform. If this is the cause, it is most important to prevent the ingress of any of the vomited matter into the air passages and this is avoided by turning the face to one or other side and pulling the jaw well forward. If no food is present, the result of vomiting will be only a little mucus.

The symptoms are always very distressing and from time to time several drugs have been recommended, but none have any specific action. As preventive measures, strict attention to the preliminary rules is important; afterwards, the head should be kept low and the patient allowed to sleep. Nothing/

Nothing should be given by the mouth for at least three hours and till all nausea has gone. After this, a little light nourishment may be allowed. For the persistent vomiting, sips of very hot water are recommended. Oxalate of Cerium, Eucaine and Codeia are useful, also an ice bag to the epigastrium; and as a last resource, lavage of the stomach should be adopted.

Failure of Respiration.

This may be due to:-

1. Asphyxia from local causes in the Respiratory tract, or may be,
2. Central in origin from poisoning of the Medullary centre.

1. Asphyxia may be caused by obstruction to the passage of air by either of the following:-

(a) The base of the Epiglottis and the Aryteno Epiglottidean folds may fall together and by occlusion of the larynx cause stertorous and irregular breathing and though no air is entering the lung, chest movements continue. The treatment is to hold the lower jaw well forward from the beginning of the anaesthesia and should it then supervene, to pull the tongue well forward. This treatment should also be used to prevent the tongue falling back, as it may do and give rise also to suffocation.

(b) Foreign bodies, such as false teeth, blood clot or other material from the field of operation, or vomited matter may pass into the larynx and so to the trachea. When signs of obstruction arise and are not relieved by pulling forward the tongue, the finger or swab must be passed round the upper opening of the larynx and any foreign body found, removed. Should suffocation due to this cause still persist, tracheotomy must be at once performed and the material removed by fingers or by suction, if fluid. Artificial Respiration or insufflation of the lungs with a catheter may also be necessary. Turning the patient upside down has also been practised.

2. Central Failure of Respiration due to poisoning of the Medullary Centre may occur at various stages and is of the greatest importance. It was shown by the Hyderabad Commissions that this is the greatest danger attending chloroform administration and that when the drug is pushed death occurs from this cause, respiration stopping some little time before the circulation. Though death from circulatory failure may occur under chloroform, then, in the first and second degrees, yet as Snow and others have shown, actual death from failure of respiration/

respiration without some initial embarrassment of circulation, are common and would be fatal were they not readily recognised and treated. Hence the importance of respiratory embarrassment as a guide to the onset of danger and the need of a careful watch over it is shown, and indicating the necessity of the withdrawal of the drug at once.

Respiratory failure may occur early in the administration and then is due to spasm of the glottis, caused by the use of too concentrated vapour, preventing elimination of the drug, which thus becomes locked up in the lungs and blood poisoning supervenes due to non-removal of the vapour.

So also by a gradual increase of the drug, the patient may pass into the fourth degree of anaesthesia and poisoning occur, the weakening of respiration preventing the elimination of chloroform from the blood. Another cause of poisoning is the sudden addition of fresh vapours, not sufficiently diluted and this acts in the same manner.

The treatment of such failure should be firstly preventive by careful watch over the respiration. Should dangerous symptoms arise, the administration must be at once stopped and this is often sufficient to/

to restore the patient. Should respiration cease, the tongue must be well drawn out of the mouth and artificial respiration resorted to either by Marshall Hall's, Sylvester's or other method. This will be normally found sufficient, if it is not too late for recovery and should be kept up for several hours before all hope is abandoned. Insufflation of the lungs by bellows with air or oxygen has also been practised with success, even in apparently hopeless cases. An hypodermic of Strychnine is given as an aid to Respiration.

Circulatory Failure.

Several cases have been recorded of early cardiac syncope following the beginning of the administration and after only a few respirations have been taken. The cause of these deaths has been never definitely explained, whether due to reflex cardiac inhibition from fear or irritation of the sensory nerve endings in the pulmonary tract. Even when some innocuous substance was inhaled, death has resulted, so probably the former is the correct explanation.

Later in the administration, failure may be due to shock following on the severity of the operation when the patient is not sufficiently under the influence/

influence of the drug. And although the common and usual cause of death in animals when chloroform is pushed is failure of the respiration, yet in some few cases where the heart is already enfeebled I think death may occur from circulatory failure; but this I do not ascribe to over-dosage per se, but to a large dose acting on an enfeebled organ. When I have had cases, as I no doubt have had, due to some cardiac failure, when such symptoms as blueness of the fingers and face and feebleness of pulse arise I have always found the pupil and conjunctival reflex a useful guide. When combined with such symptoms as I have described the pupil suddenly widely dilates and does not afterwards return to contraction, danger is indicated. Shock may also account for the loss of conjunctival reflex when sufficient chloroform has not been given to cause this. This I consider a dangerous sign and the more so when associated with loss of elasticity of the eyeball, indicating that death is impending. Such heart failure due to surgical shock is best combatted by Hypodermic injection of strychnine and ether, by inhalation of nitrite of Amyl, by application of hot bottles and by injection of brandy per rectum. Professors Oliver & Schafer have shown that suprarenal extract is a very powerful heart tonic and vaso-motor constrictor and recommend its use in the heart failure of chloroform anaesthesia. Gottlieb has also shown/

shown that in animals poisoned by chloroform until pulse has almost ceased, the circulation was at once restored by the injection of supra-renal extract into a vein.

The question of the cause of death in poisoning by chloroform vapour has long been a debatable point and numerous experiments have been performed and committee appointed to discuss the question. The Medico-Chirurgical Society's Committee was appointed in 1864. Their report, which dealt with other anaesthetics as well, was prejudicial to chloroform and held that from the experiments they performed on animals that chloroform was dangerous, that ether was safer but too slow, and recommended the use of the A. C. E. Mixture, consisting of alcohol, 1 part; chloroform, 2 parts; and ether, 3 parts.

They found that, with the strongest dose of chloroform, pulse and respiration ceased nearly simultaneously, but that the heart's action continued for a short time after. When the same dose was given through a tracheal wound instead of by the ordinary method, death occurred more quickly and the heart ceased several seconds before the respiration, but when a moderate or small dose was used, they found that respiration ceased before the heart's action, and it made no difference whether the vapour was/

was inhaled above or below the glottis. From these experiments they concluded that in the majority of cases the pulse stopped before the respiration and that the heart's action could always be distinguished some time after the pulse had ceased.

They state also that when respiration ceased it was not necessarily absolutely final, for it frequently happened that, especially when the amount of vapour inhaled was small, after some little time respiration restarted on removal of the drug. If then the administration was recommenced, respiration might again cease and be restored and this even to a third time before death finally occurred. Hence it follows that if respiration cease during the inhalation, the removal of the drug will in many cases be quite enough to allow complete recovery, the reason being that "The addition of chloroform is virtually interrupted by stoppage of respiration, whilst that which is already in the blood is gradually dissipated." It was also shown that simple failure of respiration while the circulation remains good almost always means a condition which can be recovered from either spontaneously or by artificial respiration. If it ceases whilst some pulse can be felt, recovery is probable, but if the heart has ceased or become irregular and there is no arterial pulse, then respiration by any means is doubtful.

Recovery/

Recovery is to a large extent dependent on whether the heart has been acting strongly up to the time of cessation, then it is probable; but if irregularly and feebly, it is rare. Thus an animal quickly poisoned with a large dose was more likely to recover than when the heart had been enfeebled by the long inhalation of a small dose.

As regards blood pressure Chloroform caused a preliminary transient rise, so its immediate effect is to stimulate. But after there was a gradual fall, so its ultimate effect is to depress the heart. This fall, however, was not steady, because when the respiration became shallow or fresh air was admitted less chloroform was absorbed and the heart recovered.

The Committee also investigated the results of division of the vagi. They found that the division of one vagus under chloroform produced very little effect. If both were divided the respirations were reduced to one half in number and the frequency of the heart's action increased in inverse ratio. If the vagi were divided before the administration these symptoms were modified or even absent, respiration becoming slightly less frequent or not altering. The pulse, however, became extremely rapid. but not to so great an extent as without chloroform. So chloroform relieved the discomfort caused by division/

division of the vagi in an animal. By suspending a frog's heart in chloroform and ether vapours and comparing with moist air, it was shown that these drugs have a direct action in destroying its contractile power.

The apparent irregularity in the action of chloroform which occurred, the Committee ascribed to the varying strength of vapours employed, to the quality of the drug and the constitution of the organism. This unfavourable report was upheld by the Glasgow Commission of 1879, but erroneously, because they drew from one experiment alone the conclusion that Chloroform has sometimes a capricious effect on the heart's action, and that the occurrence of sudden and unlooked for untoward results seemed to be a source of great danger. That fallacious deduction which indicated, as it was supposed, heart failure, drawn from the manometer tracing of one experiment, was afterwards proved by the Second Hyderabad Commission to be due to irritation of the vagi quite apart from the anaesthetic and to be the result of asphyxia. After these two reports were issued so unfavourable to chloroform, the drug was looked at askance and ~~avoided~~ as dangerous till the careful results of the first Hyderabad Commission were in 1888 published. This report showed chloroform/

form to be by no means the dangerous drug it was supposed, but yet these results were disbelieved and considered too favourable till the second Commission of 1889 went over the same experiments and arrived at the same conclusion. They entered into the subject very fully and from every point of view, and in order to fully understand the mechanism of chloroform narcosis they experimented on animals under the following conditions:--

- (a) Fasting,
- (b) Full stomachs,
- (c) With heart disease,
- (d) Suffering from other diseases.
- (e) Stimulated by alcohol, coffee, etc.,
- (f) Who had various alkaloids injected.
- (g) In various postures, and
- (h) Chloroformed by various methods.

They firstly make this important statement, "That the results in one respect were uniform; in every case where chloroform was pushed the respiration stopped before the heart," the interval between varying with circumstances, the shortest being when complicated by asphyxia. They asserted, moreover, that however concentrated chloroform vapour may be, it never causes sudden death from stoppage of the heart's action. When, however, chloroform was pushed/

pushed regardless of the breathing, the heart stops and its cessation is to be regarded as due to stimulation of the vagus due to asphyxia. They found that an animal in such a condition can be easily restored, for he is suffering more from asphyxia than chloroform poisoning. This corresponds to those cases where dangerous failure of the heart is said to have occurred some minutes after the administration of chloroform has been stopped and which are sometimes restored and sometimes not by artificial respiration.

The interval between stoppage of respiration and that of circulation varied from 2 to 6 minutes in uncomplicated cases. The interval was shortened under conditions of slow or prolonged administration where partial asphyxia existed and where there was much early struggling.

The Committee also agreed on the subject of recovery of respiration after its cessation, which is always due to an overdose, by artificial respiration, which acts not merely by pumping chloroform out of the blood, but also excites natural respiration. Artificial respiration was found to be nearly always successful if commenced within 30 seconds after the cessation - seldom successful if a longer time was allowed to elapse. But it is impossible to say/

say when artificial respiration will be successful or otherwise, as there may be such an overdosage in the blood that it cannot be eliminated before death occurs. This is especially the case when there is a prolonged fall of blood pressure. The Committee also agreed as to the subject of the fall of blood pressure, which they found to be gradual, but depending on the dilution of the vapour - the more concentrated it was, the quicker the fall, and vice versa. After the inhalation of chloroform is stopped the fall continues on account of the residue in the air-passages. There are two conditions which interfere with the gradual fall of blood pressure, namely, struggling, and holding the breath. Struggling, under normal circumstances, raises the pressure; but when accompanied by gasping respiration, more chloroform is inhaled, and the fall is more rapid. When the vapour is concentrated the involuntary holding of the breath causes the blood pressure to fall with great suddenness, and the heart is naturally slower. When a breath is drawn again it rises as rapidly as it fell. The combination then of holding the breath and gasping with struggling causes violent fluctuations leading to dangerous depression and over-dosage with stopping of the respiration.

Slight/

Slight asphyxia causes exaggerated and irregular oscillations of the blood pressure, with slowing and irregularity of the heart's action. Complete asphyxia causes a rapid fall and the heart's action becomes markedly slowed. This effect of asphyxia can be shown to be due to stimulation of the vagi

- (1) By their division, when it is abolished, and
- (2) By the use of atropine which paralyses them.

It is the temporary exhaustion of the vagi that is to be feared in chloroform narcosis and not their actual stimulation, for the vagi act by restraining the heart, preventing rapid bounding circulation which could lead to an increased amount of chloroform being absorbed into the blood, and death from an overdose. Further, direct irritation of the vagi proved that inhibition of the heart's action lessened rather than assisted the fatal effects of prolonged chloroform administration.

As to the action of individual drugs the Committee found that none of them had any effect in preventing the typical descent of blood pressure that occurs. Atropine by paralysing the vagi, causes a more rapid fall; Morphia appeared to render the rise of blood pressure when the drug was stopped slower and less complete and to bring about a more or less complete anaesthesia. Hence it is strongly recommended/

recommended by Lieut.Colonel Lawrie to be used as an antecedent to chloroform administration. No other drugs had any special effect except when their own particular action became the leading symptom.

As to the question of the danger of a condition of fatty heart the Committee dosed a dog with phosphorus to bring about this result, and found that the consequent feebleness had no effect in modifying the action of chloroform. Therefore it is not the action of chloroform itself in such a condition which is dangerous, but rather any exertion or struggling which may occur during the administration. For, on the other hand, the lowering of blood pressure caused by such a cardiac condition is in itself an advantage, by lessening the intake and work to be performed by the heart.

As regards Shock, the Committee stated that its effect in any stage of incomplete anaesthesia produced anything suggestive of heart failure even where operations which are supposed to particularly lead to it were performed. They found that the A. C. E. Mixture given gradually with plenty of air produces the typical manometer trace of chloroform and that given freely to a struggling animal it can produce rapid and dangerous fall in blood pressure.

In comparing these reports on the action of chloroform it will be seen that in many respects they are contradictory to each other, but the difficulties and debatable points which seem to arise can I think be elucidated and settled by a careful consideration and analysis of the Reports and the conditions under which the tests have been carried out and an explanation found for several experiments which seem inconsistent with clinical experience.

In both cases the experiments were carried out on animals and the labours of the Hyderabad Commission carried out under every condition which could occur to the minds of the investigators are founded on more careful experiments, and therefore I think the more reliable and trustworthy. Yet it is to be remembered that their experiments were made under more favourable conditions of climate and fresh air than those which exist in our own temperate climate. No doubt it can be said that ^{the effect} on the human body is to some extent different to that on animals, but I hardly think the difference is likely to be very great, more particularly when we remember that the same results which were obtained in the case of dogs held good in monkeys and anthropoid apes, the animals who morphologically most nearly approach the human type. And, surely, when the results of experiments on animals/

mals are applicable to general Medicine and Surgery, those of chloroform will also be.

The first and most important point on which the reports differ is that of the immediate cause of death. The theory of respiratory failure is strongly upheld, and I consider proved, by the Hyderabad Report and to some extent by that of the Medico-Chirurgical Society - the latter attributing death to this cause when moderate doses of the drug are used, the former when the drug is pushed. So I think we may safely conclude that respiratory failure of medullary origin, is the cause of death when poisoning due to the effects of saturation of the organism with Chloroform occurs and that when the heart afterwards ceases it is brought about by vagal inhibition due to Asphyxia.

The recovery which can be brought about merely by removal of all vapour after respiration has ceased the pulse remaining good, is an additional argument in favour of the view that respiratory failure is the common cause of death.

The Hyderabad Reports' statement that however concentrated the chloroform may be, it never causes sudden death from stoppage of the heart's action may be true of animals, but in man clinical experience has shown that death may, and undoubtedly often does occur from this cause. The Lancet Clinical Report attributes the majority of deaths to this fault and that especially is this the case when death occurs early in the administration; the exact cause of this is difficult to define; to say that it is due to some capricious effect of the drug is in the first place unscientific and in the second untrue. Such cardiac failure is more likely to be due to impurities in the drug which have a toxic effect, to struggling or exertion acting prejudicially on a fatty or dilated heart, or to fear causing cardiac inhibition, or as unfortunately so often has occurred, to the drug having been given carelessly or improperly. As to the question of shock causing cardiac failure, the/

the Hyderabad Reports' statement that death never occurred from this cause, is in a sense fallacious for they experimented with types of operation in which there was likely to be a sudden or quick shock to the nervous system rather than the operations, which by their severity and length are more likely to produce the state called surgical shock. Death has occurred from such operations as extraction of teeth and reduction of dislocations where the cause was to be traced to shock, but operations such as high amputations, abdominal or deep dissections are, I consider, more liable to lead to such a fatal result. It must also be remembered that we are dealing with the human organism whose nerve susceptibilities are more highly developed than in animals. Undoubtedly chloroform, as the fall in blood pressure shows, has a deleterious effect on the heart muscle itself and therefore acts to some extent directly on that organ, but not largely, for when it is injected directly into the circulation, it does not paralyse the heart, but produces the typical anaesthesia with a fall in blood pressure. So we must conclude that heart failure is a source of danger and that when it occurs, it does so early in/

in the administration, but that when poisoning from the drug takes place, the cause of death is to be regarded as due to failure of the respiratory centre in the medulla.

After effects of the Administration.

Bronchial trouble is rare after chloroform, but may arise if any decomposition of the vapour occurs.

Shock occurring after the operation is marked by a clammy condition of the skin, feeble pulse and shallow respirations, and is to be treated by warmth stimulants and strychnine.

Jaundice may occur and is probably due to the action of chloroform on the haemoglobin of the red corpuscles causing it to split up into haematoidin and haematoporphyrin, but soon passes off as also does the presence of albumen, or sugar in the urine. Diabetics often take the drug badly, passing into coma a few hours after, and therefore in such cases the dose should be as small as possible but is not absolutely contraindicated. The same holds good in the case of Renal Disease.

Repeated inhalations give rise to wasting of organs and muscles with fatty changes. Persons exposed constantly to the fumes are liable to suffer/

fer from neuralgia, sleeplessness and mental depression.

Use in General and Special Surgery.

There has always been much discussion as to whether chloroform or ether is the safer and better anaesthetic. Various Medical Schools and Anaesthetists upholding their own views and teachings and will always agree to differ till an absolutely safe and reliable anaesthetic is introduced. Until that time, we must be content with the ones we have at hand, both of which are toxic in large doses. Chloroform is undoubtedly more depressant than ether on the heart and blood pressure and has been the cause of more deaths, although, I think and have tried to show that in careful and experienced hands, it is by no means so dangerous and certainly has many advantages. It is more pleasant, more portable and quicker in action, causes less unpleasant after effects and certainly has not the same danger of respiratory complications which attend the use of ether. However, the choice of anaesthetic must rest with the administrator and be largely dependent on the type and nature of the operation.

Chloroform/



Chloroform is the drug par excellence for warm climates, where there is quick evaporation. Children and infants take chloroform very well, better than ether, where the apparatus frightens them. In old people, ether is inadvisable on account of the danger of respiratory after effects and in midwifery practice chloroform is largely used with great success.

Alcoholics take all forms of anaesthetics badly, but I think chloroform is better than ether when it is necessary to produce narcosis. In all diseased conditions of the respiratory system, where any dyspnoea or embarrassment exists, chloroform is to be preferred to ether since the latter increases any such condition and may give rise to dangerous after effects. In Emphysema, more than normal care must be observed on account of the weakness of the expiratory effort which increases the danger of overdosage.

Circulatory disease by no means contraindicates the use of an anaesthetic. In mitral disease, where the pulmonary circulation is embarrassed, chloroform is to be preferred to ether and acts also by steadying the heart. Chloroform is also well taken by the subjects of aortic disease and is/

is preferable, as it has much less tendency to give rise to prolonged struggling with its perhaps fatal effect on such a cardiac condition. On the other hand, Ether on account of its stimulating action is to be preferred in cases of disease of the heart wall with feeble and intermittent action, though chloroform is not absolutely contraindicated for it too has a safeguard action, the weakened Pulmonary circulation causing a lessened intake.

In aneurism or arterial disease, chloroform is to be used, as ether causes too great a preliminary rise of blood pressure; the same holds good for intracranial haemorrhage. In renal disease chloroform is less liable to increase the trouble and cause suppression, but is said to be more liable to give rise to such trouble. In collapse after severe accidents or from any cause of weakened vitality, Ether is, I think, to be preferred on account of its stimulating effect, though any anaesthetic by its removal of such a state of nervous shock acts in the same way and frequently well marked improvement of the circulation can be noted.

In cranial surgery, chloroform is indicated, as ether causes too much engorgement of the blood vessels, but the drug must be given slowly and well diluted/

diluted, as the patient is often semi-comatose with slowing of respiration and thus a small dose is sufficient to produce and maintain anaesthesia. In eye operations when a general anaesthetic is required, it is immaterial which drug is used as long as the third degree of narcosis is obtained to ensure perfect stillness, and once reached no more is required and the operation can be completed. In operations about the mouth, nose and respiratory tract, chloroform is preferable, as it can be in the later stages so easily given by means of a Junker's Inhaler with a mouth or nose tube. Ether can be used for the preliminary steps, but the cumbersome apparatus does not allow of its use in the later stages. The management of all such cases requires great care to prevent the entrance of blood and foreign bodies into the larynx, the patient only being allowed to pass into the third degree for the skin incision and for the later stages the second degree, allowing of reflex cough, is sufficient. But anaesthesia in this type of operation is often best maintained by the administration through a tracheotomy wound, the larynx being plugged. In operations on the larynx and trachea ether causes too rapid movement of these parts and is contraindicated in/

in favour of chloroform. It is recommended in such types of operation to give ether per rectum, but this with chloroform at hand is absolutely unnecessary and dangerous, several deaths having been recorded and the same careful watch must be kept over the entrance of foreign bodies into the larynx.

In the treatment of post nasal conditions, I prefer a light degree of chloroform anaesthesia to that of ether and the latter is dangerous where the cautery is being used.

For the smaller dental operations, gas can well be given in a sitting position, but when several teeth are to be extracted, chloroform, or gas and ether are to be preferred, but it is essential that they be given with the patient in a prone position. In thoracic surgery, chloroform is always to be preferred to ether, which causes too much respiratory embarrassment and so throws increased work on the heart, which is often in such conditions fatty or diseased. For the same reason, chloroform should not be pushed quite to the third degree. The second will be usually found sufficient and the necessity for turning the patient on to the healthy side of the chest demands the more careful watch. The use of ether and oxygen for the anaesthesia of this class/

absolutely?

class of cases is undoubtedly useful when dyspnoea exists.

In abdominal operations where the technique of the operation renders it necessary that the walls should be kept quiet, the use of ether is precluded so chloroform is to be preferred and to avoid all shock it should be pushed to the third degree. It is to be remembered that heart failure may occur in these operations when large evacuations of fluid are made and the heart is suddenly returned to a normal position after displacement.

In conditions of severe collapse, as in strangulated hernia, the use of ether or ether and oxygen is to be recommended rather than chloroform. In rectal operations, I think on the whole ether or gas and ether is to be preferred and pushed to narcosis of the fourth degree as the danger of rectal reflex inhibition of the heart is to be remembered.

In midwifery and obstetric operations, chloroform is always to be preferred to ether, and it is here that one of the greatest uses of chloroform is displayed, and especially so perhaps to relieve the pains of child-birth. When lightly given, the uterine contractions are but slightly lessened, but when deep anaesthesia is produced, it abolishes them, hence/

hence its usefulness in obstetric operations. It has a less irritating effect than ether on the renal epithelium and so is to be recommended in Eclampsia.

In the first stage of labour chloroform when used should be given only in small quantities from time to time and under it the patient soon passes into a state of forgetfulness of pain, yet conscious and the uterine contractions not markedly interfered with. If it is pushed in this stage, by abolishing uterine contractions and use of abdominal muscles, the necessity for the after use of instruments is increased. Deep narcosis, however, is necessary for any spasmodic condition of the Os Uteri. In the second stage, it should also be only lightly given and then during the pains. When the foetal head bears on the perineum it may be given more freely to promote relaxation of the perineal structures and to relieve the increased pain. Its ⁴rise should be stopped directly the child is expelled. In turning and instrumental deliveries, deep anaesthesia is necessary and should be given by a skilled administrator whose attention should be directed solely to the drug.

Chloroform in no way interferes with lactation or the puerperium, in fact it has some influence in shortening the latter by removing the nervous shock of childbirth and has no effect on the child.

The further uses of chloroform may be mentioned in Asthma and Angina Pectoris due to serious cardiac disease. Dr Balfour in his work on Diseases of the Heart strongly recommends its use in the latter condition and states, "That far from being unsafe in Cardiac disease, it is often of the greatest use in these cases." The drug is also most useful to produce sleep in any condition of great excitement, such as delirium from any cause. It should then be given lightly and well diluted until quietness is established and then discontinued and repeated from time to time if necessary.

It has been denied by some that it is possible to produce chloroform anaesthesia during ordinary sleep, but several cases have been recorded and I have seen it produced in order to sound the bladder. When possible to do so it is very useful and especially so in children.

Some detailed cases.

I shall now pass to some detailed description of interesting cases of anaesthesia which came under my observation in South Africa. These were for all kinds of operations from simple anaesthesia for purposes of examinations to severe and lengthy operations, such/

such as amputations for and explorations of bullet wounds, hernias, evacuation of Abscess of Liver, etc.

Hernias.

Of this operation - a common necessity among cavalry soldiers - I had in all ten cases. In all chloroform was used and the patient^s took it well, rapidly going under after some struggling, but standing the operation, lasting about thirty minutes, well. Amputations of leg and arm, of which I had seven cases were undertaken for compound fractures due to gunshot wounds and in the majority high up, one being through the shoulder and two through the thigh. The operation was well borne and terminated successfully in every case except one. This case to which I have already referred as ending fatally, was an amputation through the hip joint in the case of a Boer, who a month before had been wounded through the right knee joint and was found by our troops in a farmhouse. On admission into Hospital, he was in an advanced state of Hectic Fever due to the continued suppuration, the joint being completely disorganised and the femur bared by an abscess cavity to above the middle third. At first it was intended to amputate only above the knee, but when the surgeon found the state of the femur/

femur he wished to proceed through the hip joint. As the patient was so weakly and taking the anaesthetic none too well, I demurred against this, thinking it better to leave it till a more favourable condition. However, it was persisted in, despite stimulation with Strychnine, Ether and Brandy; the patient sank and died on the table, the cause of death being shock, I consider, as the respiration was the last to fail, the pulse becoming thin, thready and finally ceasing. In this connection I may perhaps digress a little as to the value of strychnine given hypodermically for the relief of such shock. When I considered it necessary I have always given five minims of the Liquor Strychninae before the operation and further injections during the course up to twenty minims, equal to $\frac{1}{5}$ of a grain, of Strychnine Sulphate. I must advocate the use of large doses in such cases and have never had any toxic effects for the enfeebled organism can well stand it. In talking over the subject with a colleague of the R.A.M.C., he told me of a case of his - a double amputation high up with much consequent shock and where it was necessary to trek several miles, in which he gave thirty minims of Liquor Strychninae within thirty/

thirty minutes without any toxic effects and he was convinced that it was the big dose only by which he pulled this patient through. I have never given such a big dose in a short time, but have used fifteen minims with gratifying success in several cases.

Rectal operations.

These were for Internal Haemorrhoids, a common trouble with soldiers. They were, I found, always the most difficult class of case I had to deal with on account of the rectal reflex and the difficulty, on account of evaporation, of producing anaesthesia deep enough to abolish it, even when a large amount of chloroform was given. Even after prolonged anaesthetization on stretching the sphincter ani, the greater proportion of cases became cyanosed and the breathing stertorous and difficult. However, these cases soon rallied under suitable treatment, once the dilatation was performed.

Eye Operations.

Of these I had several cases and used chloroform in all. For operations such as rectifying Strabismus and passing Lachrymal Catheters, I found a light degree of anaesthesia only necessary, but for two cases of Enucleation of the eyeball a deep degree was necessary.

Operations on the Chest.

These consisted of two cases of Empyema only. Bullet wounds of this region, of which I saw several, required no operative interference provided they were caused by the clean Mauser bullet which passed through, with symptoms of Dyspnoea and slight haemoptyses for a few days only.

Of the two Empyema cases, one is worthy of note. This was one of the Burgher National Scouts in whom the trouble was the after effects of measles, a disease which has frequently a fatal result among these people, the reason being they are not more or less immune by heredity to its ill effects. In this case for some reason the chest was not opened for some time, and when he was brought on to the table, he was in a state of marked Hectic Fever due to long continued suppuration. I gave the patient chloroform, after injecting five minims of Liquor Strychninae and the chest was opened and drained, a piece of rib being removed. He showed some signs of respiratory embarrassment and became cyanosed, but stood the operation well and without much shock. I was careful not to keep up a deep degree of anaesthesia knowing how easily a patient suffering from long standing suppuration may absorb an overdose.

Abdominal Operations.

Of this type of operation, I have not much to say as they were not common, bullet wounds of the abdomen, as experience has taught, being left severely alone. In fact the common saying is that the best thing is to pitch a tent over such a patient and leave him where he is and I know of this having been done in one case. It is proved that such wounds do best in those who have had no solid food for several hours. I had the opportunity of seeing one case where the bullet must have traversed several coils of intestine. This patient was treated solely with nutrient enemata and after some rise of temperature and great pain, made a good recovery.

I gave chloroform for two cases of abscess of the liver and the second was a very interesting case. The patient took the anaesthetic well, the second degree being sufficient for the exploratory tapping. An abscess was found deeply placed and far back and was evacuated with the trocar. An incision was then made over the right side and a piece of rib removed. The surgeon then passed his finger into the abscess cavity to explore. At once the patient, who had been taking the anaesthetic well showed signs of cardiac embarrassment, cyanosis and dyspnoea and the/

the breathing stopped. The operation was stopped and when the surgeon removed his finger from the abscess cavity, the patient returned to the previously normal condition. The operation being proceeded with, a large piece of gauze was introduced into the abscess cavity in order to drain it. At once the dangerous symptoms returned and now fully alive to the danger, it was removed and a tube inserted in place. To me, the only satisfactory explanation of these dangerous symptoms is that they were caused by pressure on the solar plexus or other deeply placed ganglia which reflexly inhibited the heart through the vagus. I am certain that had we not been fully alive to the danger of this pressure, a fatal result would have taken place. I had also one case of Nephrectomy for disorganised kidney after calculus. In this there were strong adhesions causing a prolonged operation, but the patient stood it well.

Deaths under Chloroform.

At no age of life is immunity possessed from this unfortunate sequel. In men most deaths have occurred between 24 and 50 years of age, the period during which injuries and surgical disease are commonest. In women between 21 and 45 years of age, when childbirth and operations for cancer are most frequent/

frequent. It is amongst men that fatal cases occur more frequently for the sex is more liable to accidents and operations requiring an anaesthetic.

No race or region is free from fatalities. In tropical and semitropical countries, there are very few and this, I think, is due to the way in which the houses are built for ventilation or that the operation is performed in the open. My experience in South Africa bears out this statement. Lieutenant Colonel Lawrie states that in 45,000 administrations in India, he has never had a fatal result attributable to chloroform.

It is said that twice as many deaths have occurred with the use of the open method ^{as} ~~than~~ with an inhaler, but it must be remembered that the open method is so much more frequently used and easier, so much so, that this is the method used when given by dentists and other unqualified persons.

The Causes of Death are of two kinds.

1. Predisposing. These are intemperance, which causes lowered vitality, an oedematous condition of tissues generally and the use of a larger dose. Wasting diseases, Emphysema, owing to impaired inspiration and the danger of accumulation of vapour in/
in/

in the lungs on account of lessened expiration.

Vomiting, due to loaded stomach.

2. Immediate. As regards the recorded deaths, in three fifths cardiac failure has been ascribed as the cause. In 20 per cent. respiratory failure has been the first in onset and in the remaining 20 per cent. death seems to have been due to simultaneous failure. This seems to show ~~that~~ from the clinical standpoint that heart failure is the commonest cause of death, but this by no means agrees with the Hyderabad Report. The opinion of Syme, Clover and other leading surgeons was that in some cases death occurred from primary heart failure. We must remember too that in the recorded cases the term syncope is very loosely applied and in cases ascribed to heart failure under that term, the symptoms point to asphyxia and respiratory failure as the true cause of death. These statistics, therefore, cannot be held to be absolutely reliable and we can only conclude from the clinical standpoint that the majority of cases have been due to heart failure. In practice many do occur from this, but that respiratory embarrassment is to be taken as a most important guide is acknowledged. Several deaths have occurred/

ed on a second or subsequent administration, a fact which does not support the view that death is due to heart failure owing to disease of that organ, for in that case death should have occurred at the first administration. Among the individual operations the high mortality obtaining in cases of extraction of teeth is to be noticed. The reasons seem to be the frequency of the operation, the difficulty of maintaining narcosis and preventing of foreign bodies passing into the trachea, the inexcusable use of a sitting posture and the administration by an unqualified person. It is noteworthy that in the type of operations with which we associate most surgical shock, deaths under chloroform are less common, while dental operations, dislocations, excision of joints, and operations on bones cause the greater number. In these, and especially teeth operations and reductions of dislocations there may be a tendency to give the drug ^{more} carelessly, as it may be in the out-patient department of a hospital only, than in a larger operation and the sole attention of the anaesthetist is not restricted to the administration, as he is frequently the operator as well.

In dislocations, deep anaesthesia is necessary and fatal syncope is often recorded as occurring at the/

the moment of reduction, so it would appear that then the cause is reflex cardiac inhibition, while anaesthesia was not profound enough to prevent such a conveyance of stimulus. The same may be said of rectal operations. It is probable that when a patient is only partly under the anaesthetic, the nervous elements of the cord are so affected that the check mechanism usually imposed on the reflex inhibitory system is removed, or partly so. This being the case, a skin or visceral stimulus would during incomplete anaesthesia lead to inhibition of the medullary centres and death result.

The direction of the operation is an important determining factor on account of cooling of the body; after effects, such as sickness and shock depending on the length of operation.

Undoubtedly, in a great proportion of the recorded fatal cases, the anaesthetic was given single handed by the operator, or by an inexperienced person under his supervision. In other cases, there was undoubted negligence, such as the administration after a heavy meal, in the vertical position and without that skill which should be the object of every medical man to obtain and part of the training of every student. In some cases no doubt the chemical/

chemical composition of the chloroform was at fault, giving rise to cough, dyspnoea and death. This was, as I have before stated, one of the dangers one had to contend with in South Africa where I am sure symptoms frequently arose from this cause. The importance of a careful and searching preliminary examination is emphasized by the fact that it was found that a great number of cases believed to be healthy were found on post mortem examination to be the victims of organic disease, which tended to a fatal result.

Death has occurred in all the degrees of anaesthesia.

In the first stage, where, after four or five respirations, death occurs, it is always the result of heart failure, whether from gasping respiration which causes an irregular and increased intake, or from fright.

In the second stage, the struggling which occurs is particularly dangerous on account of the irregular respiration with deep inbreaths, leading to accumulation of chloroform in the lungs. Many cases have occurred where the dose was sufficiently small and safe had a regular rate of respiration been maintained but by a long deep breath a lethal dose has/

has been absorbed. Struggling has also frequently a dangerous result on patients the subject of heart disease. In the third degree, death from respiratory failure due to over dosage is particularly common and here is associated also with irregularity of respiration. In the fourth degree, death also seems to be due to poisoning of the respiratory centre in the medulla, stertorous breathing marking the oncoming of danger. Artificial respiration may restore for the time being, but later, the patient may relapse with feeble respiration and death ensue. In the fifth degree, death is due to the same cause, but in some of these cases stertorous breathing may not give any indication of danger especially if the chin be held up, a practice which Lieutenant-Colonel Lawrie strongly condemns as he states that it removes a valuable warning of danger.

Dangerous cases where symptoms of chloroform toxæmia arise which eventually recover on the adoption of suitable resuscitative measures are very common and it is from these that much can be learned both of the warning symptoms and measures to be adopted for their relief.

The causes are usually those of respiratory failure rather than cardiac and measures for that object/

ject are usually to be recommended. These consist of admission of fresh air, artificial respiration by the various methods and by insufflation of the lungs, electricity, inversion and local and general stimulating measures, strychnine having especially such an effect on the respiratory centre.

Some figures regarding ether and chloroform mortality are of interest. From 1864 to 1892, 596 chloroform deaths are reported as compared to 45 under ether, i.e., an average of 13 to 1. But it must be remembered that chloroform is givesⁿ six times more frequently than ether, so this reduces the average to 2 to 1. In Germany, Gurlt collected statistics of one chloroform death in 2,574 administrations and one from ether in 8,433, i.e., an average of 3.2 chloroform deaths to 1 ether.

Juillard of Geneva gives the ratio as 4 to 1. On the other hand, Colonel Lawrie's large number of 45,000 chloroform administrations in India without a fatality must be borne in mind.

No doubt many of the deaths under all anaesthetics must be classed as inevitable and due to lowered vitality of the patient and not to the anaesthetic, but in such cases much will depend on the choice made. No deaths have been recorded from fear/

fear under ether and nitrous oxide, probably because of their initial stimulation.

The post mortem conditions found after an overdose of chloroform vary according to the stage of anaesthesia. The lungs are much congested and the heart empty, containing only a little blood which is always fluid and of a dark colour. When asphyxia has occurred the right heart is filled with dark coloured blood. The nervous system is found to contain the largest proportion of chloroform, but in common with all the tissues, it is soon dissipated. When present, it is split up into chlorine and hydrochloric acid and this can be tested by the ordinary tests, i.e., reddens the blue litmus paper and gives a white precipitate with silver nitrate.

When chloroform has been swallowed it exerts its caustic effect. Such an individual will be found to be comatose, breathing stertorously with shallow respirations face and extremities livid and pulse very small. Pupils widely dilated and not reacting to light breath smelling of the drug if seen soon. The following post mortem appearances will be found. Rigor mortis, slight; blood fluid and cavities of the heart engorged. In the stomach the mucous membrane is enflamed, red patches of congestion/

gestion with the rugae of the fundus blackened, are seen, but no erosion. So in the small intestine dark red spots with black bands of valvulae conniventes. The large intestine and other organs are normal.